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Factors Affecting College Students' Knowledge and Opinions of Genetically Modified Foods

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Abstract

The use of biotechnology in food and agricultural applications has increased greatly during the past decade and is considered by many to be a controversial topic. Drawing upon a previous national study, a new survey was conducted of U.S. and international college students at a large, land-grant, Research University to determine factors that may affect opinions about genetically modified (GM) food products. Factors examined included nationality, discipline area of study, perceptions of safety, and awareness and levels of acceptance regarding GM food. Results indicated students born outside the United States had more negative opinions about genetically modified foods than did American-born students. Students who were studying a physical science-based curriculum had a more positive opinion of GM food than did students studying a curriculum that was not based in the physical science. In addition, students who reported a higher level of acceptance of genetically modified foods felt more positively about the safety of the technology.

Introduction

The use of biotechnology in food and agriculture has increased greatly during the past decade (Comstock, 2001; Knight, 2006). Global use of genetically modified (GM) plants has increased rapidly since their commercial introduction in 1996. Desirable traits (e.g., insect and herbicide resistance and improved nutritional content) have resulted in a large increase in the number of hectares planted globally. The prevalence of GM crops has increased every year since their introduction, and this will continue (James, 2008). Consumer opinions are important to the success of technological innovation in the marketplace. The purpose of this study was to examine college students' opinions in the areas of awareness, acceptance, and safety of GM foods with regard to nationality and field of study. The survey model is based upon a national survey concerning biotechnology.

Genetic modification of foods is one of many examples of the gap between scientists and nonscientists (Chappell & Hartz, 1998). Accordingly, Hoban (2001) stated that consumer awareness and understanding of biotechnology innovation has grown slowly. Despite the increased use of GM food products, GM technology is not well understood in the United States. Several recent surveys demonstrate this lack of understanding by the American public (Falk et al., 2002; Hallman & Hebden, 2005; Hallman, Hebden, Cuite, Aquino, & Lang, 2004). Although 60 to 70% of food products sold at supermarkets include ingredients using genetic modification, many consumers remain unaware of their use (Byrne, 2006). A lack of understanding among the public may lead to uncertainty about the safety of GM food products (Byrne, 2006, Hoban, 2001; Shanahan, 2003).

Consumer opinion of GM food safety also differs by nationality (Knight, 2006). Research reveals that U.S. consumers are the least concerned about GM food safety issues whereas European and Asian consumers report more concern (Chern, Rickertsen, Tsubio, & Fu, 2003; Fritz & Fischer, 2007; Pew Initiative, 2005). Even after more than a decade of debate and the increased support of governments in South America and China, the European Union and environmental groups, such as Friends of the Earth, continue to reject the cultivation and use of genetically modified crops (Weise, 2010).

College students form a subpopulation of the general public and an area of interest concerning GM food opinions. Within the United States, college students may mingle among nationalities, a previously cited factor of perceptions concerning GM food safety. College students are likely to be younger and more highly educated than the general population and may have a greater awareness of agriculture biotechnology (Finke & Kim, 2003). Science-based coursework, laboratory work, and the beliefs of professors and instructors may contribute to awareness, and these beliefs may be reinforced within the student's major area of study. As young adults, students may not have formed a strong opinion about this subject, and they may be more open to the different perspectives of agriculture biotechnology (Wingenbach, Rutherford, & Dunsford 2003).

College graduates are more likely to be more open-minded, and they have been shown to have lower prejudice levels and increased knowledge of global issues (Rowley & Hurtado, 2002). Concerning GM food products, college students in the United States show a lack of understanding about the concepts and processes behind GM technology. Wingenbach, et al. (2003) found that even though college students surveyed felt confident in their knowledge of biotechnology practices, only 30% answered the questions correctly. A weak relationship was found between the students' perceived and actual knowledge of biotechnology and between students' assessed knowledge and level of acceptance for biotechnology practices (Wingenbach, et al., 2003).

Nationality has been found to be a significant factor in college student opinion concerning GM foods, just as it has been with the general population (Gaskell, 2000; Hallman & Hebden, 2005; O'Fallon, Gursoy, & Swanger, 2007). In a study of Korean and American students, approximately 42% of U.S. students expressed concern about health risks from GM food and over 86% of Korean students felt the same level of concern (Finke & Kim, 2003). Only 14% of Korean students surveyed felt no concern compared with 42% of U.S. students who perceived no concern about the health risks of consuming GM foods.

When compared with previous research, this study is based on a wider demographic of students and included all students enrolled at a Midwestern land-grant research-intensive institution. Additionally, the international students participating in this study were students at an American university. In previous studies, the students were enrolled at universities in their home countries (Finke & Kim, 2003; Li., Curtiss, McCluskey, & Wahl, 2002). Unlike previous research, students from all disciplines were included versus students in specific disciplines (Finke & Kim, 2003; Wingenbach et al., 2003). All of these differences have the potential to affect students' knowledge and opinions.

Methodology

To measure awareness, acceptance, and safety perceptions, a previously validated instrument was utilized (Hoban, 2001). Four-scaled response items were used to determine respondent awareness, usage acceptance levels, and safety perception regarding GM foods. When measuring awareness, four-point scales were used ranging from "none" to "a lot." To determine the awareness of the students, two questionnaire items were used. The first asked the students how much they had heard about genetically modified food products, and the second item asked if they had consumed a product containing GM foods. This methodology was employed because past research has indicated that very few Americans surveyed know the extent of GM ingredients contained within foods sold in the United States. Several studies have found very low numbers of Americans surveyed have been able to correctly answer survey questions about consumption of GM foods. In this case, the assumption was that students who knew a lot about GM foods would also recognize that they had most likely consumed GM products (Falk et al., 2002; Hallman & Hebden, 2005; Hallman et al., 2004; Pew Initiative, 2003).

The relationship between awareness and acceptance was also explored. One theory of awareness and acceptance is that the more people know about a biotechnology, the more intense their support or opposition will be for this topic (Fischoff, 1995). An additional outcome of increased awareness is an emotional response that the GM foods were "hidden" from them without their consent (Hoban, 2001). The third item on the survey was used to explore the relationship between the variables of awareness (both perceived and actual) and safety perception.

The final item on the survey queried students on their support of the use of genetic modification in food and agriculture areas. This item measured the students' acceptance of GM technology as applied to food and agriculture, and it was tested against field of study, nationality, and awareness levels to determine if a significant relationship existed. The relationship between acceptance levels and safety perceptions of students was also tested.

Three additional questions asked students about their nationality and field of study. Students indicated their field of study on the questionnaire and were also asked to identify the academic unit where their major was administered. Researchers classified the majors as either physical science based or non-physical science based. The instrument is shown in Figure 1.

Physical science is defined by the *Merriam-Webster Dictionary* (2009) as fields in which the

1. How much have you heard about genetically modified food products?
   a. A lot b. Some c. Little d. Nothing

2. Have you consumed genetically modified food products?
   a. Yes b. No c. Not sure

3. How safe are genetically modified food products?
   a. Safe b. Unsafe c. Not sure

4. Do you support the use of genetic modification in agriculture and food?
   a. Yes b. No c. Not sure

5. To what College does your academic discipline belong?
   a. Agriculture b. Business c. Design
   d. Engineering e. Human Sciences f. Liberal Arts & Sciences

6. What is your major?

7. What is your nationality?
   a. American-born b. Born internationally

Figure 1. Questions from the data collection instrument.

properties of energy and nonliving materials are studied. Although physical science is strictly defined by fields such as physics, chemistry, astronomy, and geology, some overlap with fields in the biological sciences is often apparent. These fields might include biochemistry, biophysics, virology, and paleontology. In the case of this study, physical science fields included disciplines such as agricultural biochemistry, food science, and meteorology, in addition to the subject areas listed in the definition.

The instrument was pilot tested on a small subgroup of the target population (n = 26). The seven-item survey was administered electronically to the student body attending an upper Midwestern land-grant research-intensive university. A cover letter preceded the survey to brief subjects about the project and its purpose. Consent of respondents was assumed if the student voluntarily clicked on the link to begin the survey. Because participation was voluntary, a delimitation of the study was the self-selection of the student sample. Data collection was guided by three research questions:

1. Do college students have an accurate awareness of their knowledge of GM food technology?
2. Do nationality, field of study, or acceptance levels affect college students' perceptions of safety concerning GM foods?
3. Does college students' level of acceptance for GM foods vary by nationality or field of study?

Using SPSS, version 14, frequency distributions were performed on demographic characteristics (field of study, nationality, and academic college of enrollment) and cross-tabulations were carried out for awareness and consumption patterns. To test whether a relationship existed between variables the Chi-square test of independence was used (Agresti & Finlay, 1999, pp. 261-262). On selected variables, adjusted residuals were studied to learn more about the nature and strength of the relationship identified by the Chi-square test of independence (Agresti & Finlay, 1999).

Results

Valid questionnaires were received from 762 students. The responses were representative of the total campus population regarding field of study and nationality (Iowa State University Office of Institutional Research, 2005). Table 1 shows the characteristics of the students surveyed. Uneven sample sizes are the result of missing data.

Table 1. Characteristics of Student Sample

Nationality[1]	Frequency	Percentage
American	718	94.3
International	43	5.7
Major [2]		
Physical Science	361	47.6
Non-Physical Science	344	45.4
Unsure 53	7.0	
Academic Unit of Major[3]		
Agriculture	191	25.9
Business77	10.4	
Design 39	5.3	
Engineering	188	25.4
Human Sciences	214	29.0
Liberal Arts & Sciences	30	4.1

[1]$N = 761$; [2]$N = 758$; [3]$N = 739$

Frequency data for the question on awareness of GM foods are presented in Table 2. The results illustrate a student body relatively confident in its knowledge of GM foods, with nearly 75% of the students stating they had either some or a lot of knowledge. Less than 4% of students surveyed had heard nothing about genetic modification of foods.

Table 2. Student Awareness Levels Concerning GM Foods

Awareness Level	Frequency	Percentage
Heard Nothing	29	3.8
Heard a Little	170	22.3
Heard Some	349	45.8
Heard a Lot	214	28.1

[1]$N = 762$

Awareness and consumption were compared in Table 3 to answer the first research question asking if college students have an accurate perception of their knowledge of GM food technology. Students were queried about both awareness levels and consumption patterns to see if these variables aligned. These data suggest that awareness and consumption do align: students who had more awareness were more likely to believe they had consumed GM foods. Students who had less awareness were more likely to be uncertain about their consumption patterns.

Table 3. Cross-Tabulation of Perceived Awareness and Consumption of GM Food Products

Consumption[1]	No	Not Sure	Yes	Percentage
Awareness[1]				
Nothing	0	26	3	3.8
A Little	3	130	37	22.3
Some	5	146	198	45.8
A Lot	4	22	188	28.1
Percentage	1.6	42.5	55.9	100

[1]$N = 762$

The Chi-square test of independence was used to test the associations of safety perceptions with field of study, nationality, and level of acceptance. Level of acceptance was tested for associations with field of study and nationality. Table 4 illustrates the associations found among survey variables using the Chi-Square test of independence. Four of the five variable pairs tested showed evidence of a dependent relationship.

Adjusted residual analysis was used to determine the nature and relative strength of the relationships identified as dependent (Agresti & Finlay, 1999, pp. 261-262). The difference between the observed frequency of a specific variable pair and its expected frequency creates a value called the residual. A positive residual occurs when the observed frequency is greater than the expected frequency needed to predict an independent relationship, and a negative residual occurs when the observed frequency is smaller than the expected frequency needed to predict an independent relationship between the two variables (Agresti & Finlay, 1999, pp. 261-262).

An adjusted residual value above 2 provides evidence against the null hypotheses of an independent relationship between each pair of variables and adjusted residual values above 3 are considered strong evidence for a significant relationship between the two variables (Agresti & Finlay 1999, pp. 261-262). Table 5 illustrates the pairs of associations and their standardized adjusted residuals.

The pairs of variables exhibiting evidence of an association or a strong association are identified in Table 5. The adjusted residual values greater than 2 suggest students who study in physical science-based majors are more likely to feel positively about the safety of GM foods than those who study in fields outside the physical science areas. Additionally, American students were found to feel more positively about the safety of GM foods than did international students, as measured by the adjusted residual values greater than 2. Finally, adjusted residual values provide evidence that college students who study in physical science-based majors are less likely to be uncertain regarding their

Table 4. Chi-Square Values and Significant Levels of Variable Pairs

Variables	Chi-Square Value	Degrees of Freedom	Significance Level
Safety Perceptions / Field of Study[1]	9.96	4	0.041*
Safety Perceptions / Nationality[2]	9.80	2	0.007*
Safety Perceptions / Level of Acceptance[1]	419.90	6	0.000*
Level of Acceptance / Field of Study[3]	9.78	4	0.044*
Level of Acceptance / Nationality[2]	1.68	3	0.641

[1]*n* = 758; [2]*n* = 761; [3]*n* = 762; *Significant at _ = .05

Table 5. Residual Values of Relationships with Safety

Levels of Safety Perceptions	Field of Study		
	Physical Science	Non-physical science	
Safe[1]	2.7*	-2.2*	
Unsafe[1]	0.8	-0.7	
Unsure[1]	-3.1**	2.5*	
	Nationality		
	American-born	Internationally-born	
Safe[2]	2.6*	-2.6*	
Unsafe[2]	-2.3*	2.3*	
Unsure[2]	-1.6	1.6	
	Acceptance Levels		
	Yes	No	Unsure
Safe[3]	14.6**	-9.4**	-9.6**
Unsafe[3]	-8.4**	15.1**	-2.1*
Unsure[3]	-11.3**	3.1**	10.7**

[1]*n* = 705; [2]*n* = 761; [3]*n* = 762; *evidence of association; ** evidence of strong association

Table 6. Residual Values of Relationships Between Acceptance Variable Pairs

Levels of Acceptance	Field of Study	
	Physical Science	Non-physical Science
Yes[1]	1.7	-1.7
No[1]	1.3	-0.7
Unsure[1]	-2.9*	2.5*
	Nationality	
	American-born	Internationally-born
Yes[2]	-0.2	0.2
No[2]	-1.0	1.0
Unsure[2]	1.0	-1.0

[1]*n* = 705; [2]*n* = 760; *evidence of association; ** evidence of strong association

support of GM food products than are college students studying in non-physical science areas.

The strongest relationships in the safety perceptions group are with levels of acceptance. These data suggest those who are more supportive of GM foods are more likely to feel these foods are safe, and people who do not support GM food products are less likely to think the foods are safe, as shown by the high positive residual values for high acceptance and perceptions of safety. High negative values for negative and uncertain acceptance levels with a positive perception of safety illustrate a strong negative relationship between the factors of acceptance levels and perceptions of safety.

Discussion and Implications of Research

The survey sample was drawn from the student body at an upper Midwestern land-grant university. Students from all academic areas of the university were represented. The results suggest students have an accurate understanding of their knowledge of GM food as represented by awareness and consumption. Students who believed they had greater awareness also believed (correctly) that they had consumed GM food. Of those who believed they had at least a little knowledge of genetic modification in

foods, over 94% thought they had consumed GM foods, whereas less than 4% of students who professed at least a little knowledge of GM foods believed they had not eaten the foods.

Assuming knowledge of consumption also represents awareness, the low numbers of respondents who professed a lot of knowledge, but no consumption may also be individuals who pay very close attention to what they eat rather than consumers who have overestimated their knowledge. Avoiding GM foods requires a great deal of effort and an unusually advanced knowledge of the food and agriculture system (Hallman & Hebden, 2005; Pew Initiative, 2003; Wingenbach et al., 2003). However, it must be acknowledged that although it is difficult to not consume foods made with GM products in the United States, it is not impossible.

Finally, the strongest relationship found among variables was between acceptance and safety: students who were unsure about their acceptance of GM foods were also more likely to feel uncertain about the safety of the products. This finding is clearly illustrated by the strength of the evidence provided by the standardized adjusted residuals for an association between the variables of acceptance and safety. If strong evidence for association is provided by residuals of 3 or greater, the extremely high positive residuals between high levels of acceptance and high safety perceptions (residual value = 14.6) highlights a very strong relationship between the two. Those who had high levels of acceptance also showed a strong negative association with high uncertainty (residual value = -11.3) and low safety perceptions (residual value = -8.3).

The same relationship patterns were apparent with low levels of acceptance and uncertain acceptance. Those who had low acceptance levels also believed that GM foods were unsafe (residual value = 15.4). Students who were uncertain concerning their acceptance of GM foods were more likely to also feel uncertain about the safety of GM food products (residual value = 10.6). Accordingly, those who were uncertain about their acceptance of GM foods were also less likely to have high perceptions of safety (residual value = -9.7).

Nationality appears to play a role in the safety perceptions of college students, because American students felt more positively about GM technology as used in food and agriculture and international students felt more negatively about it. However, student nationality and acceptance levels were unrelated, contradicting previous findings (Finke & Kim, 2003).

Field of study was a relevant factor: physical science students were less likely to be uncertain about both safety perceptions and levels of acceptance. Physical science students felt more positively about safety (residual value = 2.7) than non-physical science students (residual value = -2.2), and this aligns with a previous study (Priest, 2000). This is a more novel area of study with regard to biotechnology: relatively few studies include how field of study affects a student's opinion of biotechnology.

The relationship between academic discipline of the students and their perceptions of safety and acceptance illustrates the continuing divide between scientists and nonscientists on topics considered controversial (Chappell & Hartz 1998; Priest 2000). Priest (2000) found people who have a broad university-level science education are more likely to feel more positively about the use of genetic modification in foods; this study found that physical science students felt more positively about the safety of GM foods and were less likely to be uncertain in their acceptance of the technology than were students who were not studying in a physical science discipline.

Although students of physical science have been shown to have stronger positive safety perceptions and likely to be more certain regarding their acceptance of GM technology in this study, these findings have broader implications for scientific communication. It is often the nonscientist who does the communicating, in the form of marketing, writing, or education on scientific topics such as genetic modification of foods. Students in areas other than physical science were found to be less certain in their acceptance of GM foods and less confident in the safety of these foods. Increased scientific and technical training for the nonscientist on controversial science topics (such as genetic modification of foods) could address some of these knowledge gaps.

There were also several delimitations to the study. The population chosen for this study was drawn from a single university, and it may not be representative of U.S. college students in

general. The students self-selected when responding to the survey. Those who elected to take part in the study may have perceptions, knowledge, and opinions quite different from those who did not participate. Uneven and small group sizes among international students prevented researchers from dividing this group further. Some students provided unclear descriptions of majors, and these were classified as unknown and were not included in the Chi-square tests of independence. All of these factors may limit the ability to generalize the results of this study.

Future research in this area is recommended, especially in the area of academic discipline with additional factors of acceptance and safety perceptions. Similar research among multiple universities would improve the ability to generalize results to a wider population. Students are an important section of the general population; they also represent the next generation of leaders helping to shape public opinion about biotechnology, and, in general, technology awareness, and adoption. Thus, understanding students' knowledge of and opinion on the topic of biotechnology use in foods is important to both the scientific community and the nonscientific community.

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